

### III. How are Water Quality Assessments Performed?

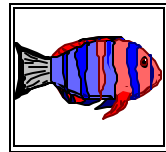
#### Do all waters have to meet the same standards?

**Standards and Designated Uses** -- Arizona sets narrative and numeric surface water standards for water quality based on the uses people and wildlife make of the water. These “designated uses” are specified in the standards for individual surface waters, or if the surface water is not listed in the rule, the designated uses are determined by the tributary rule, based on the most likely uses including downstream uses. Surface waters have multiple designated uses, while aquifers are protected for drinking water use, unless specifically reclassified. Water quality is judged acceptable or impaired based on standards established to protect each designated use.

Surface water standards are reviewed and revised on a three-year cycle. These standards are established in Arizona Administrative Code (A.A.C.) R18-11-101 through R18-11-123 plus appendices. Ground water standards (A.A.C. R18-11-401 through R18-11-506) are revised as new drinking water protection standards are adopted. The numeric surface water quality standards adopted in 1996 were used in this assessment, although new surface water standards may be adopted and approved by EPA before this report is published, they were not in effect when the assessment was made. The surface and ground water quality standards used in this assessment are included in **Appendix C**.

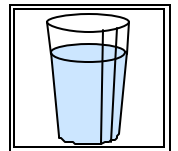
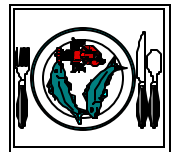
**Designated Use Classification** -- Six groups of designated uses can be applied to surface waters. All bodies of water regulated by these standards (except canals) are protected for aquatic and wildlife uses and recreation in or on the water (either Full Body and Fish Consumption or Partial Body Contact).

- **Aquatic and Wildlife.** Four categories of aquatic and wildlife protection have been established. All surface waters, except canals, have one of these:
  - < Warmwater aquatic community (A&Ww),
  - < Coldwater aquatic community (A&Wc),
  - < Effluent dependent water (A&Wedw),
  - < Ephemeral flow (A&We).



Aquatic and Wildlife criteria are also divided into acute criteria (established based on short exposures) and chronic criteria (established based on long-term or life-time exposures.)

- **Full Body Contact (FBC) or Partial Body Contact (PBC)** criteria were established to maintain and protect water quality for swimming, water skiing, boating, and wading. The FBC criteria are to protect public health when people engage in full immersion in the water and potential ingestion. The PBC criteria are to protect people who engage in water-based recreation where full immersion and ingestion of the water are unlikely (wading, fishing, boating).
- **Fish Consumption (FC)** water quality criteria were established to protect human health from pollutants which may bioaccumulate in aquatic organisms (e.g., fish, turtles, crayfish) and be consumed by people.
- **Domestic Water Source (DWS)** criteria are applied to surface water that is used as a raw water source for drinking water supply. The criteria were developed assuming that conventional water treatment (disinfection and filtration) would be needed to yield water suitable for human consumption.
- **Agriculture Irrigation (AgI)** criteria were established to protect water used for irrigating crops.
- **Agriculture Livestock Watering (AgL)** criteria were established to safeguard water used for consumption by livestock.



**Narrative Standards** -- Narrative surface water standards (A.A.C. R18-11-108) were established to protect water quality when a numeric standard is not available or is insufficient (**Appendix C**). The new state TMDL statute requires development of narrative implementation procedures before narrative standards can be applied to 303(d) listing decisions. These documents are under development but were not available for this assessment.

Narrative aquifer water quality standards also exist to protect ground water quality. These standards similarly prohibit discharges that would cause or contribute to a pollutant being present (A.A.C. R18-11-405) (**Appendix C**).

## Do some waters have special standards to meet?

**Unique Waters Classification and Antidegradation Standards** – A Unique Water is a surface water classified by ADEQ as an outstanding state resource water (as prescribed in A.A.C. R18-11-112). Twenty streams have been established as Unique Waters in Arizona (**Figure 11**).

ADEQ may classify a surface water as a unique water through the rule making process if it meets one of the following criteria:

- The surface water is of exceptional recreational or ecological significance because of its unique attributes, including but not limited to attributes related to the geology, flora, fauna, water quality, aesthetic values, or wilderness characteristics of the surface water, or
- Threatened or endangered species are known to be associated with the surface water and existing water quality is essential to the maintenance and propagation of a threatened or endangered species, or the surface water provides critical habitat for a threatened or endangered species.

Public comments in support or opposition to a Unique Waters nomination are considered by the Department in making the decision on classifying a water as meeting one or both of these criteria.

Unique waters are given more stringent surface water quality protections than other surface waters under the state's antidegradation rule A.A.C. R18-11-107(D). Under antidegradation implementation procedures, activities that may result in a new or expanded discharge of pollutants to Unique Water (or its tributaries) are prohibited if the discharge would cause degradation of existing water quality. Discharges include those caused by land use activity (e.g., construction, mining, grazing, agriculture) as well as discharges requiring a surface water discharge permit (e.g., wastewater treatment plant discharge, adit, dredge and fill activity).

Additional, more stringent, numeric standards can be specified for Unique Waters. These site specific standards are listed in the surface water standards (A.A.C. R18-11-112).

**Effluent Dependent Water** – ADEQ classifies some waters as effluent dependent waters (**Figure 12**). These surface waters would generally be ephemeral, except for the discharge of treated effluent. Designated uses are limited to Aquatic and

Wildlife effluent dependent water, Partial Body Contact, and in some places Agriculture Livestock Watering.

Arizona has developed specific Aquatic and Wildlife effluent dependent water (A&Wedw) standards for bacteria, water temperature, dissolved oxygen, and acute and chronic toxic chemical criteria (**Appendix C**). In general these standards are less stringent than other Aquatic and Wildlife designated uses, the exception being fecal coliform that is more stringent because of the likelihood of pathogens in wastewater.

**Moderating Provisions** – Dischargers have had the opportunity to establish a “mixing zone,” “nutrient waiver,” or “variance” through the NPDES/AZPDES permit process. These moderating provisions provide an alternate standard on the surface water.

- A mixing zone is a prescribed area or volume of surface water where initial dilution of the discharge takes place. A mixing zone can only be established if there is adequate water for dilution; therefore it cannot be applied to an ephemeral drainage.
- A nutrient waiver can be established (for total phosphorus or total nitrogen) for a discharge to an ephemeral water which is a tributary to a surface water with nutrient standards, if there is evidence that the downstream water does not have excessive algae, aquatic plants, or other indications of excessive nutrient loading due to the discharge.
- ADEQ can also grant a pollutant specific variance for a point source discharge for up to five years where:
  1. The permittee demonstrates that the treatment is more advanced than the technology-based effluent limitations needed to comply with the water quality standards, but
  2. It is not technically feasible to achieve this level of treatment within the next five years, or the cost of such treatment would result in unacceptable social and economic impacts.

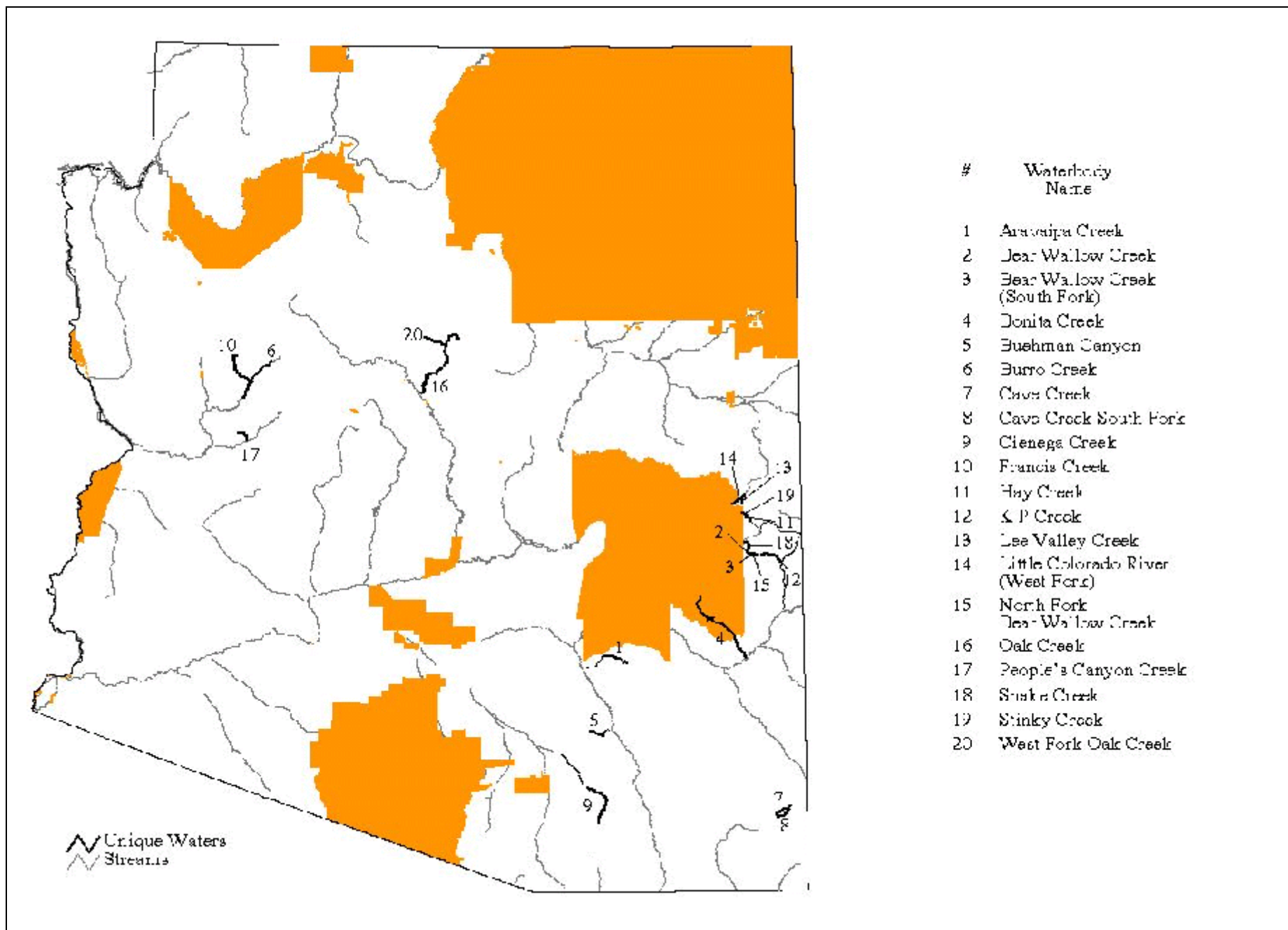


Figure 11. Unique Waters in Arizona

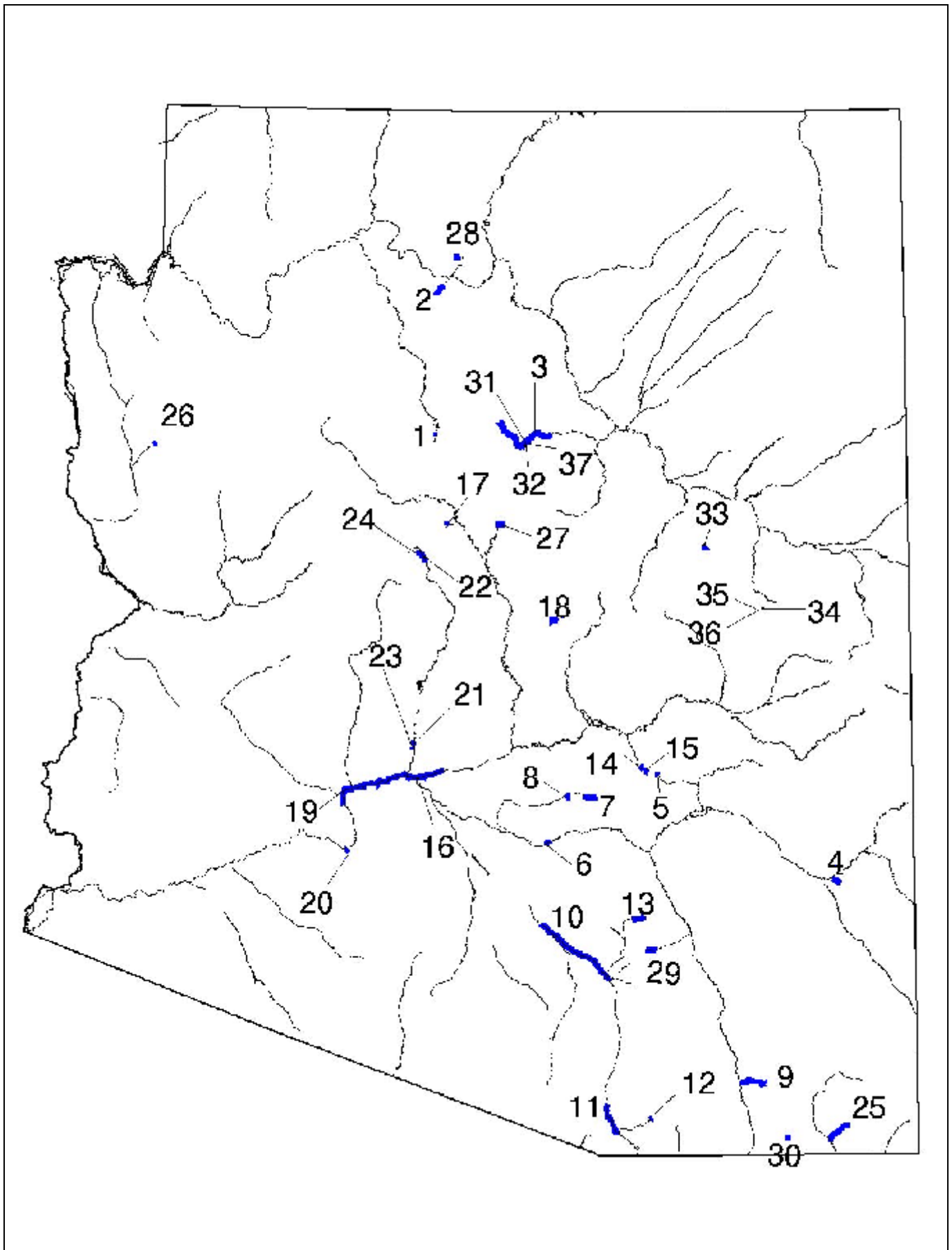


Figure 12. Effluent Dependent Waters in Arizona

**Effluent Dependent Waters – Table for Figure 12**

<b>Map #</b>	<b>Surface Water Name and Wastewater Treatment Plant (WWTP)</b>	<b>Map #</b>	<b>Surface Water Name and Wastewater Treatment Plant (WWTP)</b>
1	Cataract Creek below Williams WWTP	21	Agua Fria River below El Mirage WWTP
2	Bright Angel Wash below So Rim of Grand Canyon WWTP	22	Agua Fria River below #24 (Prescott Valley WWTP)
3	Rio de Flag below Flagstaff WWTP	23	Unnamed wash to Luke Air Force Base WWTP
4	Bennet Wash below ADOC*-Safford WWTP	24	Unnamed wash to Agua Fria below Prescott Valley WWTP
5	Unnamed wash below ADOC*-Globe WWTP	25	Unnamed wash to Whitewater Draw (Bisbee Airport WWTP)
6	Gila River below Florence WWTP	26	Holy Moses Wash below Kingman WWTP
7	Queen Creek below Superior WWTP	27	Jack's Canyon Wash below Big Park WWTP
8	Unnamed wash below Queen Valley WWTP	28	Transept Canyon below No. Rim Grand Canyon WWTP
9	Walnut Gulch below Tombstone WWTP	29	Unnamed tributary to Alder Wash below Mount Lemon WWTP
10	Santa Cruz River below Pima County Roger Road WWTP	30	Mule Gulch below Bisbee WWTP
11	Santa Cruz River below Nogales International WWTP	31	Lake Humphreys from Flagstaff WWTP
12	Sonoita Creek below Patagonia WWTP	32	Wale Lake from Flagstaff WWTP
13	Unnamed wash below Oracle WWTP	33	Dry Lake from Stone Container WWTP
14	Pinal Creek below #15 (Globe WWTP)	34	Pintail Lake from Show Low WWTP
15	Unnamed wash below Globe WWTP	35	Telephone Lake from Show Low WWTP
16	Salt River below Phoenix 23 <sup>rd</sup> Avenue WWTP (Phoenix metro WWTPs)	36	Ned Lake from Show Low WWTP
17	Bitter Creek below Jerome WWTP	37	Lower Walnut Canyon Lake from Flagstaff WWTP
18	American Gulch below the No. Gila County WWTP	38	Lake Cochise
19	Gila River below #16 to Gillespie Dam (Phoenix metro WWTPs)		
20	Unnamed wash from Gila Bend WWTP		

\* ADOC = Arizona Department of Corrections

## How does ADEQ assess a surface water?

In assessing surface water quality there is always a risk of concluding that a surface water is impaired when it is not, or concluding that a surface water is attaining its uses when it is actually impaired. Either of these errors involves a cost. Concluding that a surface water is impaired when it is not, results in a use of resources that should be utilized elsewhere. Concluding that a surface water is not impaired when it actually is, results in not addressing existing environmental degradation and human health threats. To reduce the risk of either of these errors, the assessment process has been modified since the last assessment.

**Generalized Assessment Process --** A surface water is assessed based on all readily available, credible, and scientifically defensible monitoring data and information pertaining to possible numeric and narrative standards violations. Each designated use is assessed, then these assessments are combined to provide an overall water quality assessment and to determine whether the Department needs to take further actions.

The rest of this section describes the details of this process.

**Data Collection and Review--** For this assessment, ADEQ reviewed all readily available surface water quality data collected during the five-year period beginning October 1995. Data was requested from all federal and state agencies who routinely collect water quality data, including water chemistry, sediment contamination, bioassessments, fish tissue, fish kills, weed harvesting, physical habitat information. EPA's STORET database was queried. (STORET is EPA's storage and retrieval system for housing surface water data from federal and state agencies.) The assessment team also made an effort to track down all surface water quality data collected through permit compliance, remediation, and enforcement programs within this agency, from universities, and from volunteer monitoring programs.

All data obtained was reviewed to determine whether it met the requirements in the new Impaired Waters Rule (A.A.C. R18-11-602 and 603, see **Appendix B**) for being credible, scientifically defensible, and representative. These requirements can be summarized as:

- Data must be collected and analyzed using an appropriate Quality Assurance Plan and Sampling Analysis Plan, and using field and laboratory methods by adequately trained personnel.

- Data must be evaluated to determine whether it is reliable, representative of current water quality conditions, and valid by considering factors such as: laboratory detection limits, equipment tolerances, outliers which may indicate laboratory or transcription errors, representativeness of the sampling location, seasonal distribution of the samples, age of the data, and quality control of the data when collected and analyzed.

**Data Conflicts and Weight-of-evidence Assessments --** Assessment monitoring considers multiple environmental indicators. Each type of data (e.g., biological, toxicological, physical, and chemical) provides its own insights into the integrity and health of an aquatic system and the ability of the public to safely recreate in or use such waters. Each type of data also has different strengths and limitations. For example, chemical water samples generally evaluate and predict impacts from single pollutants, but do not capture the combined interactions of pollutants or cumulative impacts over time. Some chemicals may be found in high levels in fish tissue or sediments while available laboratory methods cannot detect their presence in the water column.

To make an assessment, apparent data conflicts must be resolved. Arizona uses a "weight-of-evidence" approach in completing assessments. The strengths and limitations of each data set are considered, looking at all of the data and exceedances in context with relevant information such as soil type, geology, hydrology, flow regime, geomorphology, natural processes, potential anthropomorphic influences, characteristics of the stressors, age of the data, monitoring techniques, sampling plan, and climate.

Although multiple lines of evidence are desirable, only one line of water quality evidence may be sufficient to demonstrate that the surface water or segment is impaired or not attaining its uses.

Data or information collected during critical conditions may be considered separately from the complete dataset. A surface water may be impaired only during critical conditions such as high or low stream flow, weather conditions, or anthropogenic activities in the watershed, even though it is attaining standards during all other conditions.

## Assessment Criteria

Most of Arizona's assessments are based on numeric water chemistry data. To determine whether there is sufficient data and that the data is representative of the surface water being assessed, the following attributes must be considered: core parametric coverage, number of samples, number of sampling events, seasonal distribution of samples, and sample locations. The criteria for having sufficient data are described in the following paragraphs.

**Spatial and Temporal Considerations** – To determine whether there are sufficient samples and sampling events to support an assessment, first it must be determined that the samples are spatially and temporally independent. Samples are spatially independent if they are collected more than 200 meters apart; or if collected less than 200 meters apart, samples were taken to characterize the effect of an intervening tributary, outfall, pollution source, or significant hydrographic or hydrologic change. Samples are temporally independent if they are collected at the same location but more than seven (7) days apart.

If samples are not spatially or temporally independent (e.g., samples taken at different depths in a lake), the data will be represented by a calculated value. The method for calculating these values varies by type of surface water standard. If the standard was established to protect from immediate or acute impacts, then a maximum or worst case value for the data set is used. Examples of standards developed for acute exposures include: dissolved metals, chlorine, dissolved oxygen, and acute ammonia. However, if the standard was developed based on concern for lifetime or long-term exposure, then an appropriate measure of central tendency (e.g., mean, median, geometric mean) is used. Most standards to protect uses for fishing, drinking, fish consumption, and agricultural uses fall into this second category.

**Assessment Categories** – As shown in the assessment process diagram (**Figure 13**), the number of exceedances, samples, seasonal distribution, and other assessment factors required for an assessment vary. The following criteria are applied to assess a surface water. First individual designated uses are assessed. Then the entire reach or lake is assessed by combining the individual assessments.

- **Attaining** -- To assess a designated use as “attaining,” the following minimum data requirements must be met:

- < Samples collected:
  1. Represent at least three spatially and temporally independent sampling events;
  2. Represent multiple seasons, or if limited periods of flow (ephemeral or intermittent), samples are collected across multiple years; and
  3. Include core parameters for each designated use (**Table 5**);
- < Number of exceedances:
  1. No numeric standards were exceeded and no evidence that a narrative standard was violated; or
  2. Exceedance was due to an activity specifically exempted in surface water standards (see following discussion of exempted exceedances ); or
  3. If any numeric standards were exceeded, there are:
    - a. 10 or more spatially independent samples,
    - b. Collected during three (3) or more temporally independent sampling events, and
    - c. Fewer exceedances than required for addition to the Planning List based on Table 1 in the Impaired Waters Rule (see **Appendix B**).

Surface waters are assessed as “attaining” their uses fall into three categories:

- < **Attaining All Uses** – All designated uses were assessed as “attaining.”
- < **Attaining Some Uses** – At least one designated use was assessed as “attaining” and all other uses were assessed as “inconclusive” (see “inconclusive” criteria below). These waters are added to the Planning List for further monitoring.
- < **Threatened** – A use would be assessed as “attaining” except that a trend analysis indicates that a standard may be exceeded before the next assessment. These surface waters are added to the Planning List for further monitoring.

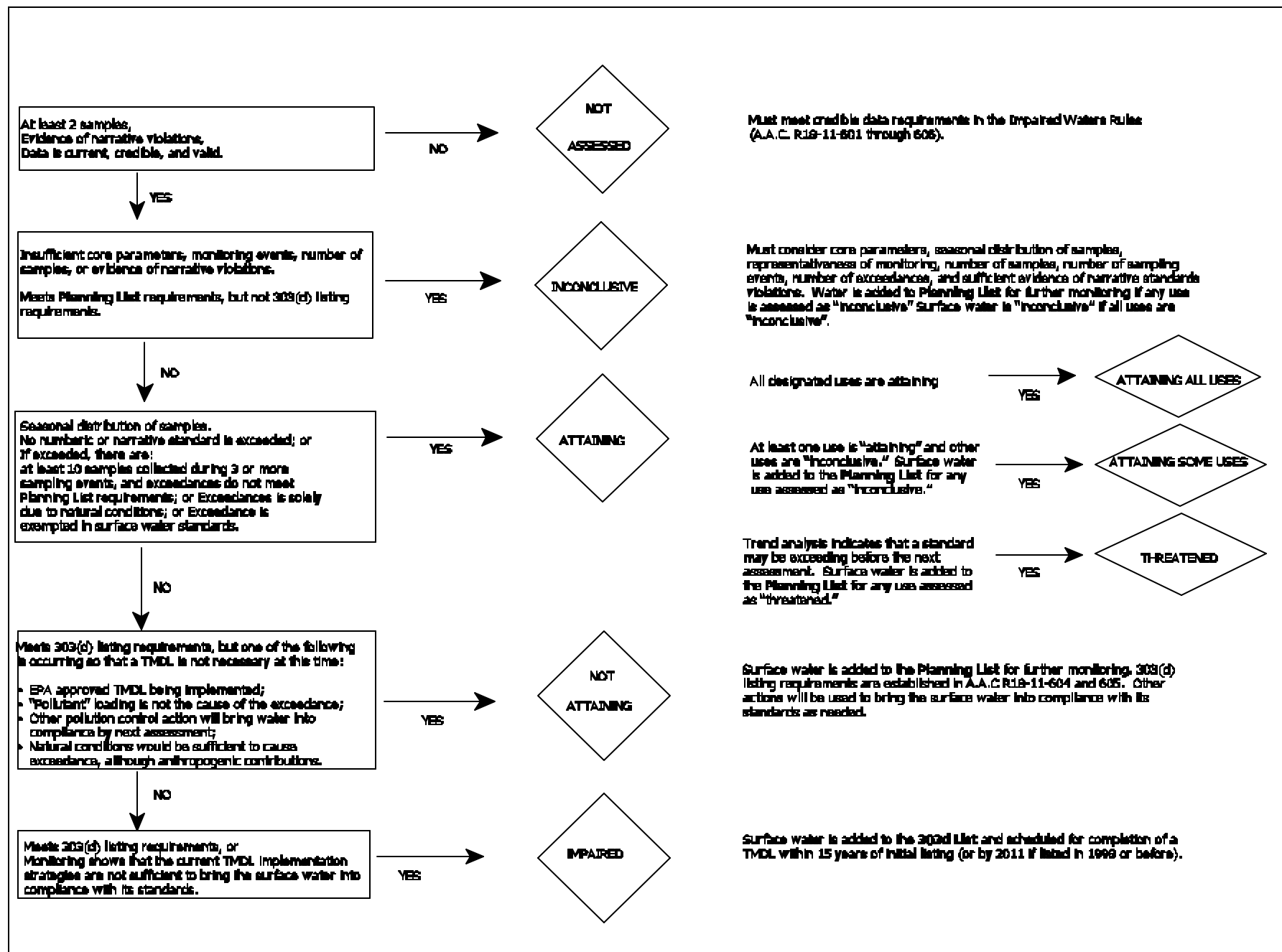


Figure 13. 2002 Assessment Process Diagram



- < **Impaired and Not Attaining** – The exceedance is recurring, persistent, or occurring under critical conditions. The Impaired Waters Identification Rules (**Appendix B**) establishes the following criteria:

**Impaired** – A designated use is “impaired” if any of the following occur:

- < At least 20 samples were collected during three (3) or more sampling events and the minimum number of samples exceeded a standard, as established in the Impaired Waters Rules Table 2. This table starts with a minimum of five (5) exceedances among 20 samples. (These numbers were calculated to provide a 90% statistical confidence that a standard is exceeded at least 10% of the time), or
- < An acutely toxic pollutant exceeded its surface water quality standard more than once in a three-year period. Acutely toxic pollutants include the following surface water standards:
  1. Aquatic and wildlife acute toxic standards;
  2. Nitrate or nitrate/nitrite standards; and
  3. Single sample maximum standards for bacteria; or
- < More than one exceedance of the following statistically-based criteria in surface water standards:
  1. An annual mean or 90<sup>th</sup> percentile for nutrients.
  2. 30-day geometric mean for bacteria; or
  3. Aquatic and wildlife chronic criteria.

If one or more designated use is “impaired,” the surface water is listed as “impaired,” included on the 303(d) List, and scheduled for completion of a TMDL for the listed pollutant.

**Not attaining** – A designated use has been assessed as “impaired” except that one of the following is occurring so that the preparation of a TMDL is not appropriate:

- < A TMDL has been prepared, approved by EPA, and is in the strategy implementation and effectiveness monitoring phase; (Note that if the monitoring shows that the strategies chosen are ineffective at bringing the surface water into compliance with its standards, the surface water will be placed back on the 303(d) List) or
- < The surface water is expected to attain its designated uses by the next assessment as a result of pollution control programs

under local, state, or federal authority, and evidence of such actions are carefully documented; or

- < Investigations have shown that impairment is not caused by a “pollutant” loading, but is classified more generally as “pollution.” For example, physical limitations such as the shallowness of the lake are causing the low dissolved oxygen and high pH levels rather than nutrient loadings or nutrient cycling. In such cases, a loading calculation such as a TMDL might not be as relevant as development of site-specific standards or a use attainability analysis.

If any designated use is assessed as “not attaining,” the surface water is added to the Planning List for further monitoring. The surface is listed as “not attaining” if any designated use is “not attaining” and no uses are “impaired.”

- **Inconclusive** – A designated use is assessed as “inconclusive” when some surface water monitoring data exists but it is insufficient to make an assessment of “impaired,” “not attaining,” or “attaining.” This assessment is used when any of the following occurs:

- < There are sufficient exceedances of water quality standards to be placed on the Planning List but insufficient exceedances to be placed on the 303(d) List;
  1. Based on frequency of exceedance, if:
    - a. 10 or more spatially independent samples,
    - b. Collected during three (3) or more temporally independent sampling events, and
    - c. Exceedances equal to or greater than the Planning List Table 1, but insufficient samples or exceedances for 303(d) List Table 2 (see **Appendix B**);
  2. If fewer than 10 spatially independent samples and three (3) or more exceedances of any of the following standards:
    - a. Appendix A, Table 1, except for nitrate or nitrate-nitrite, established to protect for swimming, drinking, eating aquatic life, or agriculture;
    - b. Water temperature, turbidity, radiochemicals, dissolved oxygen, pH, or single sample maximums for nutrients in A.A.C. R18-11-109; or
    - c. Unique water single sample maximum standards (except chromium) in A.A.C. R18-11-112;
  3. An exceedance has occurred, but insufficient frequency of

exceedance to merit assessing as “impaired” (see earlier criteria), and not enough samples or sampling events to determine that it is “attaining” (see earlier criteria);

- < Insufficient core parameters, seasonal representation, or other information needed to assess (see criteria for “attaining”);
- < The surface water was on the 303(d) List in 1998, but was delisted because of:
  1. Insufficient current credible data to determine that the surface water is impaired (see “impaired” criteria); and
  2. Original data does not meet the “impaired” waters requirements; or
  3. The surface water no longer meets the criteria for impairment based on a change in the applicable surface water quality standard or a designated use approved by EPA, and there is insufficient current or original data to determine whether the surface water meets current surface water quality standards. (This did not occur in this assessment.)
- < Some evidence of a narrative standard violation exists. For this assessment, evidence of narrative standards violations included: fish kills, fish consumption advisories, swimming area closures, and excessive weed growth combined with indications that pH and dissolved oxygen may not be attaining standards. (For this assessment, no surface waters were placed on the 303(d) List based solely on narrative standards violations as ADEQ is still developing suitable narrative implementation procedures for determining that the surface water is “impaired” and belongs on the 303(d) List.)

If any use is “inconclusive,” the surface water is added to the Planning List for additional monitoring and investigation. The surface water is assessed as “inconclusive” if all of its designated uses are assessed as “inconclusive.”

- **Not assessed** – A number of surface waters in the state were not assessed due to a lack of monitoring data. Only those with some monitoring data or information about narrative standards violations appear on the monitoring and assessment tables. Surface waters would not be assessed if any of the following occurs:
  - < No monitoring data, only one sample collected, or no standards established for data collected (e.g., total dissolved solids) and no evidence of narrative standards violations; or

- < Data does not meet credible data requirements established in the Impaired Waters Identification rule (A.A.C. R18-11-602, see **Appendix B**) (e.g., lacking a quality assurance plan or sampling analysis plan, or sampling techniques not appropriate, holding times not met).

**Core Parametric Coverage** – Although all parameters with numeric standards are used for this assessment; a core set of parameters was established for each designated use (**Table 5**). These core parameters must be monitored during at least three independent sampling events to determine whether a specific designated use assigned to the surface water is “attaining.”

Core parameters were selected based on EPA guidance in the draft CALM document (EPA, 2001). This guidance places emphasis on narrative standards, suggesting that core indicators would include: bioassessments, habitat assessments, ambient toxicity testing, contaminated sediment, health of individual organisms, nuisance plant growth, algae, sediments, and odor and taste. Arizona’s choice of core indicators may change in future assessments as standards change and other assessment tools and criteria are developed.

**Table 5. Core Parametric Coverage**

Required to Assess a Designated Use as “Attaining” Uses	
<b>Aquatic and Wildlife:</b>	Dissolved oxygen, flow (if a stream) and depth (if a lake), pH, turbidity, total nitrogen <sup>1</sup> , dissolved metals <sup>2</sup> (specifically copper, cadmium, chromium, and zinc) and hardness.
<b>Fish Consumption:</b>	Metals <sup>2</sup> (specifically total mercury)
<b>Full Body or Partial Body Contact:</b>	<i>Escherichia coli</i> (if FBC), fecal coliform (if PBC), pH, metals <sup>2</sup> (specifically arsenic, beryllium, manganese).
<b>Domestic Water Source:</b>	Nitrate/nitrite or nitrate, pH, fluoride (fluoride) and metals <sup>2</sup> (specifically arsenic and barium).
<b>Agriculture Irrigation:</b>	Boron, pH, and metals <sup>2</sup> (specifically manganese).
<b>Agriculture Livestock Watering:</b>	Metals <sup>2</sup> (specifically copper and lead) and pH.
<sup>1</sup> Nitrogen is required only in surface waters with nutrient standards. <sup>2</sup> Metals are required only at sites with current or historic mining activities in the drainage area.	

**Exempted Exceedance of Standards** – Surface waters are not assessed as “impaired” if the exceedance is specifically exempted in Arizona’s surface water standards or Impaired Waters Identification rules (**Appendix B and C**). If an exceedance occurred, but was related to the following conditions or situations, they would be noted in the monitoring tables, but not used as evidence of impairment:

- Naturally-occurring conditions (A.A.C. R18-11-119). For this assessment, the naturally-occurring conditions exempted included:
  - < Low dissolved oxygen occurring due to documented ground water upwelling;
  - < Areas minimally impacted by human activity, where springs are the source of a pollutant due to natural deposits; or
  - < Minimally impacted drainage areas, such as a small drainage in the Grand Canyon National Park, where excess turbidity is due to natural erosion of sandstone geological formations.
- Operation and maintenance of a canal, drain, or municipal park lake (e.g., dewatering, dredging, and weed control) (A.A.C. R18-11-117);
- Routine physical or mechanical maintenance of dams and flood control structures may cause increases in turbidity (A.A.C. R18-11-118); and
- Discharge of lubricating oil associated with start-up of well pumps which discharge to canals (A.A.C. R18-11-117).

Note that some bodies of water are not defined as a “surface water” in Arizona’s surface water quality rules (e.g., wastewater treatment systems, lagoons, or impoundments). Surface water quality standards would not apply to these waters.

## How much of a lake or stream is assessed?

Numerous hydrologic, geologic, and land use factors must be considered when determining the amount of a lake or stream that can be assessed based on each monitoring site. By default, Arizona assesses an entire surface water “reach” or lake based on one or more monitoring sites (**Figure 14 and text box**).

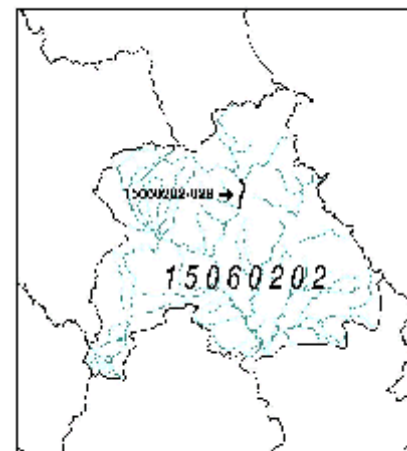
As more monitoring data become available, differences in water quality in portions of a reach or a lake may become apparent, and the reach or lake is segmented. This has frequently occurred during TMDL investigations, as the extent of contamination becomes more defined.

**New National Hydrography Dataset** – Recently, a new National Hydrography Dataset (NHD) was developed by EPA and USGS that is replacing EPA’s old

reach file system. In Arizona, the NHD uses approximately the same digitized hydrography as the latest reach file system. The current assessment will be converted into the NHD by EPA using Arizona’s revised GIS coverages, linking assessment data to the waterbody identification number. To complete this conversion, EPA will need to add a significant number of relatively small tributary streams and urban lakes to the NHD that are named in Arizona’s surface water standards or have been monitored as part of special studies.

### Reach Definition and Delineation

The US Geological Survey (USGS) has divided streams across the United States into drainage areas or Hydrologic Unit Code areas (HUCs). The Environmental Protection Agency then divided the streams into reaches based on hydrological features such as tributaries and dams, and provided a unique number for each stream reach. These numbers eliminate the ambiguity caused by many streams in Arizona having the same common name (e.g., Sycamore Creek). These reaches have been further divided by ADEQ due to changes in designated uses, hydrology, and documented changes in water quality. In **Figure 14**, 15060202 is the HUC and 028 is the reach.



**Figure 14. Reach Delineation**

How do lake and stream assessments differ?

The depth of a lake adds an additional level of complexity to an assessment. Samples are frequently collected at multiple levels in a lake because lower levels of a lake may have naturally higher chemical concentrations, especially when the lake is “stratified.” Stratification is a natural process in which several horizontal water layers of different density may form in a lake. During stratification, the bottom layer (hypolimnion) is cool, high in nutrients, low in light, low in productivity, and low in dissolved oxygen. The top layer (epilimnion) is warm, higher in dissolved oxygen, light, and production, but normally lower in nutrients. The sharp boundary between the two layers is called a thermocline (metalimnion). Lake stratification is caused by temperature-created differences in water density.

Some measurements are more commonly taken in lakes or are used in a different way in lakes than in streams. For example, Chlorophyll-*a*, Secchi depths, and volatile suspended solids results are compared to total suspended solids and turbidity values to determine whether excessive turbidity is actually related to a planktonic algal bloom and potential excessive nutrients or is related to suspended sediments and potential excessive lake sedimentation.

**Trophic Status --** In addition to comparing water quality monitoring results with standards, ADEQ classifies lakes according to trophic status. Lakes are classified in a continuum of lake stages from low productivity to high productivity as nutrients accumulate or are depleted in the system.

- Oligotrophic - Low algal or plant productivity
- Mesotrophic - Medium algal or plant productivity
- Eutrophic - High algal or plant productivity, and
- Hypereutrophic - Very high algal or plant productivity and light-limited  
(Algae shades available light, inhibiting further growth)

A trophic classification is included in the assessment tables in Chapter V. The “Trophic Status Index” used in this assessment integrates phosphorus, nitrogen, Secchi depth, and Chlorophyll-*a* data, as indicated in **Table 6**. This trophic classification is based on: Brezonik, Patrick L. 1986. “Trophic State Indices: Rationale for Multivariate Approaches”, *Lake and Reservoir Management*, USEPA, Office of Water. 440/5/84-001, pages 441-445. The lakes program

plans to refine this trophic analysis in the future by accounting for macrophytes, algal diversity, and biovolume.

Given sufficient time, lakes go through a natural trophic progression accumulating nutrients and biomass. However, activities within the watershed may unduly speed up this process. It is important to note that most lakes in Arizona are constructed and their hydrologic design (e.g., shallow, with little water flow through) may create management challenges such as high productivity and sedimentation.

Table 6. Trophic Classification Thresholds

	TROPHIC STATUS			
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic
Trophic Status Index	<30	30-45	45-65	>65
Chlorophyll-a (µg/L)	<5	5-12	12-20	>20
Secchi Depth (meters)	>3	1.2-3	0.6-1.2	<0.6
Total Phosphorus (mg/L)				
Phosphorus-limited	<10	10-20	20-35	>35
Nitrogen & Phosphorus-limited	<13	13-35	35-65	>65
Total Nitrogen (mg/L)				
Nitrogen-limited	<0.25	0.25-0.65	0.65-1.1	>1.1
Nitrogen & Phosphorus-limited	<0.28	0.28-0.75	0.75-1.2	>1.2

Nitrogen- limited = nitrogen : phosphorus ratio is <10.  
Phosphorus-limited = nitrogen : phosphorus ratio is > 30.  
Nitrogen and phosphorus-limited (colimited) = nitrogen : phosphorus ratio is 10-30

Public availability of monitoring data

ADEQ continues to look for ways to share the data used in this assessment report with the public. Monitoring data are summarized in the watershed monitoring tables in Volume II. These data tables indicate which agency and program collected the data, the amount and type of data, and dates collected, frequency of exceedances, and more. Ambient surface water quality data collected by ADEQ staff can be obtained through EPA’s STORET database on the internet at <http://www.epa.gov/STORET>.